NATIONAL ASSOCIATION OF COST ACCOUNTANTS

Affiliated with The Canadian Society of Cost Accountants

Official Publications

Vol. III, No. 16 May 15, 1922

# Distribution of Operating Costs of Centralized Power Plants at Low Capacity

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MAY 15, 1922

## DISTRIBUTION OF OPERATING COSTS OF CENTRALIZED POWER PLANTS AT LOW CAPACITY

### Publication Department Note

In addition to this publication the Association has issued other materials on the distribution of costs under abnormal conditions. The Year Book, pages 192-242, contains the treatment of this subject at the Convention in Cleveland. Bulletin No. 20 (New Series), pages 129-132, contains some material on this subject also.

During the war period many important manufacturing companies throughout the country built large power plants to serve two or more local manufacturing units, conveniently situated nearby, or which it was contemplated would be built under expansion programs so numerous during that period. Industrial depression came along in many cases in the fall of 1920 with the resultant necessity for decrease in production, and consequent reduced requirements for the product of the power plants, i.e., steam for various purposes and electrical energy. Such organizations now find themselves in possession of perhaps efficient but nevertheless expensive power plants, which have a capacity far in excess of present needs or those of the immediate future. The cost per unit of power of such power plants when operating at 50% or less of capacity, frequently exceeds the price of corresponding power purchased from public utility corporations. Many small concerns are now buying power from public utilities. Without discussing the judgment prompting the erection of such power units, some large and ably managed companies now find themselves in the rather difficult situation mentioned above. Competition promises to be keen during the ensuing few years. Manufacturing costs undoubtedly must be reduced to the lowest point, but nevertheless they must be accurate. Power cost usually is an important element of manufacturing overhead. It is true that under most circumstances, it would not be reasonable to suggest the disuse of such power plants. Having in mind the requirements of a dependable cost accounting system during periods of extremely competitive market conditions, the solution of the problem must be largely a matter of efficiency and of proper accounting until business conditions again reach normal. The excessive cost of operating such power plants should be absorbed through operations showing profit and loss it is true, but in such a manner as not to load manufacturing costs of these plants used as a basis for setting selling prices.

## Rates Based Upon Normal Production

A fixed rate for power and steam should be established upon the basis of normal production. Each plant served should be charged at these fixed rates in accordance with consumption as determined from meter readings. This charge would be the one entering into each plant's Manufacturing Expense. Such a distribution would still leave undistributed an amount representing the net cost of unused capacity of the power plant. Each plant would receive an additional charge each month to be taken up in a loss or gain account under the general grouping Other Charges, in an account entitled Net Cost of Unused Capacity—Power Plant, or some similar name. The balance in this account each month would be a deduction from gross (manufacturing) profit. This additional charge for each plant would be determined each month as the difference between the cost of power consumed by it during the month priced at normal fixed rates, and an amount representing its proper share of the total expense of the power plant for the month. The share of the total actual expense which each plant should bear each month should not be based only upon the ratio of normal consumption of each plant to total normal power plant capacity, nor upon the ratio of actual consumption of each plant to total actual production of power plant, but for proper charging of power both factors should be considered.

The principles involved and the necessary calculations to be made can be explained best by working out a hypothetical case as illustrated below. Let us assume a power plant has been built which under normal conditions would cost $50,000 per month to operate, and has been erected to serve three manufacturing units with power and steam. When these facts are reduced to a percentage basis the following ratio would be established:

*Ratio per Original Estimate*

| | |
|---|---|
| Plant A— | 20% |
| Plant B— | 30% |
| Plant C— | 50% |
| | 100% |

The power plant, however, operates during a certain month on a 50% capacity basis at a cost of $35,000, and the actual consumption of power, let us say, is in accordance with the following ratio:

*Ratio of Actual Consumption*
*(50% of Normal Capacity)*

| | |
|---|---|
| Plant A— | 30% |
| Plant B— | 30% |
| Plant C— | 40% |
| | 100% |

A common though erroneous practice is to obtain the unit cost of power for the month by dividing the total expense of the power plant by the consumption (production), and to charge each plant's manufacturing expense in accordance with its usage. The final result of such a distribution would be as follows:

*Illustration* 1

| | *% Per Actual Consumption* | *Amount* |
|---|---|---|
| Plant A— | 30% | $10,500 |
| Plant B— | 30% | 10,500 |
| Plant C— | 40% | 14,000 |
| | 100% | $35,000 |

A different and more accurate result would be obtained when distribution is made upon the basis of normal fixed rates. As these rates in the instance under consideration would be based upon a certain normal capacity at an estimated cost of $50,000, it is obvious that on a 50% capacity basis one-half of $50,000 ($25,000) would be distributed to the three manufacturing units, resulting in charges to Manufacturing Expense of these three plants as shown in Illustration 2. The amount of these charges at fixed rates, of course, would not be calculated on a percentage basis, but would be expressed as kilowatts or pounds of steam in accordance with meter readings, extended at fixed normal rates. The resultant amount would be exactly the same, however, and the method employed in the illustration (2) is used to eliminate technicalities as far as possible.

*Illustration* 2

| | *% Actual Consumption* | *Amount Distributed at Fixed Rates* |
|---|---|---|
| Plant A— | 30% | $ 7,500 |
| Plant B— | 30% | 7,500 |
| Plant C— | 40% | 10,000 |
| | 100% | $25,000 |

## Distribution of Unabsorbed Power

A balance of $10,000 of power plant expense still remains for distribution direct to the profit and loss of the three manufacturing plants. In the case under review 50% of power plant capacity has been lost, resulting in an increase of $10,000 in expense above normal or, in other words, $200 for each per cent unused. Under a proper method this excess cost should be distributed to the several manufacturing plants according to the degree by which each failed to consume power to which committed, the failure having caused the increased cost. The calculation necessary in this case is shown below.

*Illustration* 3

| | *Normal to which Committed* | *Actual Consumption (50% capacity)* | *Proportion of Normal Unused* | *Excess Cost Factor per 1% Unused Capacity* | *Distribution of Unabsorbed balance of Power Plant Expense (Excess Cost)* |
|---|---|---|---|---|---|
| A | 20% | 30% | 5% | $200 | $1,000 |
| B | 30% | 30% | 15% | 200 | 3,000 |
| C | 50% | 40% | 30% | 200 | 6,000 |
| Total | 100% | 100% | | | $10,000 |

Having distributed the total actual expenses of the power plant upon an equitable basis, let us consider the viewpoint of the individual who would insist upon absorbing all power plant expense solely in the manufacturing expense of the manufacturing units (and consequently include it in costs of production).

## Determination of Actual Rate

The calculations shown in illustrations 2 and 3 must still be made in order to determine the amount of actual expense properly chargeable to each manufacturing plant. The common and erroneous practice referred to previously of obtaining an "actual" rate for the month by dividing the total power plant expense by its production, and of charging each manufacturing plant by the rate so obtained, in accordance with its consumption, would result in a very different and incorrect distribution. Illustration 4 shows a correct method of determining the "actual" rate for each manufacturing plant, which properly may be different in each case.

*Illustration* 4

| | *Cost of Power at Fixed Rates* | *Amount of Excess Cost Applicable* | *Total* | *Percent "Actual" rate of Normal Rate* |
|---|---|---|---|---|
| A | $ 7,500 | $ 1,000 | $ 8,500 | 113 1/3% |
| B | 7,500 | 3,000 | 10,500 | 140% |
| C | 10,000 | 6,000 | 16,000 | 160% |
| Total | $25,000 | $10,000 | $35,000 | 140% |

An average increase in the fixed rate of 40% is shown in the above illustration. This is obtained by dividing the excess cost ($10,000) by the amount ($25,000) representing a calculation based upon fixed rates. The accuracy of the above calculation of percentages readily can be verified by assuming a fixed unit rate, and definite quantities of power units such as pounds of steam or kilowatts. For ease in illustrating assume a fixed rate of $1.00, and that plant A's actual rate for the month is $1.13⅓; plant B's, $1.40; and plant C's $1.60. Let us analyze why the actual rate for plant B is exactly the same as the average rate, and observe

how this tends to demonstrate the accuracy of the hypothesis upon which the calculations are based. Illustration 3 shows that plant B was committed to 30% of normal power plant expense, and that it also consumed 30% of the actual total. It has relatively fulfilled its obligations; plant A did more and plant C less, and the "actual" rates for them properly reflect such conditions.

## Methods Summarized

The various factors discussed separately in preceding paragraphs are brought together in Illustration 5.

*Illustration* 5

| Plant | 1<br>Per Orig. Est.<br>(3 plus 5)<br>Standard Expense to which Committed<br>Amount | 2<br>(3 plus 6)<br>Proportion of Actual Expense<br>Amount | 3<br>Metered<br>(1 minus 5)<br>Consumption at Fixed Rates<br>Amount | 4<br>(1 minus 2)<br>Burden Variances<br>Amount | 5<br>(1 minus 3)<br>(4 plus 6)<br>Cost of Unused Capacity<br>Amount | 6<br>(2 minus 3)<br>(5 minus 4)<br>Net Undistributed Expense<br>Amount |
|---|---|---|---|---|---|---|
| A | $10,000 | $ 8,500 | $ 7,500 | $ 1,500 | $ 2,500 | $ 1,000 |
| B | 15,000 | 10,500 | 7,500 | 4,500 | 7,500 | 3,000 |
| C | 25,000 | 16,000 | 10,000 | 9,000 | 15,000 | 6,000 |
| Total | $50,000 | $35,000 | $25,000 | $15,000 | $25,000 | $10,000 |

It is of interest to note the effect of the two methods to which reference has been made, on the profit and loss of the units involved. A comparison is presented below as Illustration 6.

*Illustration* 6

| | Total | Plant A | Plant B | Plant C |
|---|---|---|---|---|
| Amount incorrectly distributed to Manufacturing Expense (per Illustration 1) | $35,000 | $10,500 | $10,500 | $14,000 |
| Amount distributed to Manufacturing Expense (per Illustration 2) | 25,000 | 7,500 | 7,500 | 10,000 |
| Additional Amount distributed direct to profit and loss (per Column 6, Illustration 5 | 10,000 | 1,000 | 3,000 | 6,000 |
| Total Charges First Method | 35,000 | 10,500 | 10,500 | 14,000 |
| Total Charges Proposed Method | 35,000 | 8,500 | 10,500 | 16,000 |
| Net Difference | None | –$ 2,000 | None | +$ 2,000 |

It is to be noted that while there is no difference in the *total* charge of plant B through the use of either method, a proper distribution is recorded between manufacturing and other expense through the use of the suggested method.

The hypothetical case used above has been prepared purposely in order to set forth clearly the accounting principles involved. When correct principles are used, a resultant practice may be expected to properly cover all requirements, even to extremes, without modification.

An analysis of the results for plant A, as shown on Illustration 5, therefore is of interest. Column 1 shows $10,000 as plant A's commitment on the basis of normal capacity of the power plant and normal requirements of plant A. Column 2 shows an amount of $8,500 as plant A's share of the total actual operating expense of the power plant, calculated as shown in Illustration 4, the principles of which distribution obviously are correct. Certainly, if the power plant was not operating, it would still have expense for fixed charges, etc., which would have to be distributed to operations having a profit or loss account. In such an instance there would be no relative consumption ratio, and the expense necessarily would be distributed in accordance with original estimates of each plant for power requirements. If only one of the three plants uses power in small quantities, it would certainly be incorrect to load it with the total power expense, the other two plants absorbing none.

Having established the accuracy of the amounts in column 1 and 2 of Illustration 5, the amounts in columns 3 to 6 inclusive therefore are merely the result of correct cost accounting. Column 3 shows the charge for power per meter readings extended at the fixed rates established upon the basis of normal power plant capacity. Column 4 shows the amount of burden variance, being the difference between the standard and actual expense. Column 5 shows the cost of unused capacity. In addition to the two methods of proof as shown at the top of column 5 (column 1-3) or (4 + 6), the same cost of unused capacity would be obtained by subtracting the quantity consumed, expressed in technical terms as pounds of steam, kilowatts, etc., from the original commitments, and multiplying the result by the fixed rates established.

$25,000 is shown in column 5 as the cost of unused capacity for plant A. The accuracy of this may be demonstrated in the following manner: The original commitment was for 20%, but only 30% of 50% capacity was used or, in other words, 75% of its commitment, leaving 25% unused. 25% of $10,000 (column 1, Illustration 5) equals $2,500 as shown in column 5, Illustration 5. Plant A properly would stand a charge for its cost of unused capacity ($2,500) but would also receive credit for an amount representing its relative proportion of burden variance, ($1,500) resulting in a net charge of $1,000 for unabsorbed power plant expense.

The principles outlined in this article, when practical, could be applied with equal justice in the departmental distribution of power of a single manufacturing plant for purposes of dependable cost accounting, or for that matter, to distribute the expense of any department or unit whose service definitely can be measured.